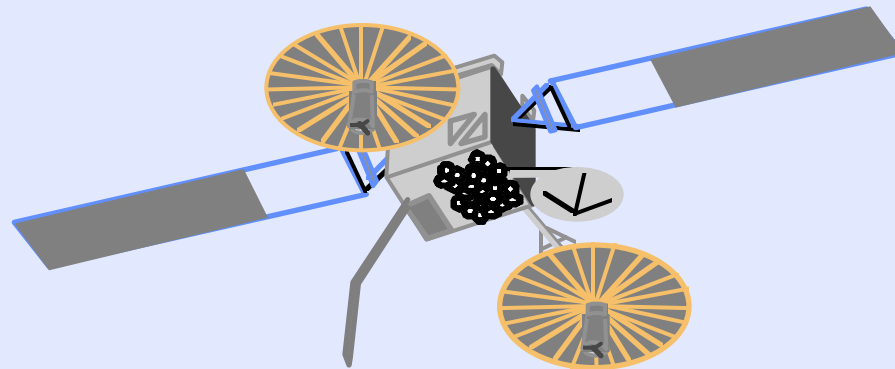
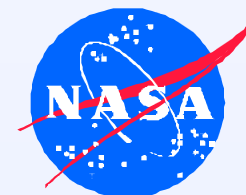


Technical and Operational Considerations That Should Be Adopted By The Fixed Service To Facilitate Sharing With The Inter-Satellite Service In The Frequency Band 25.25-27.5 GHz

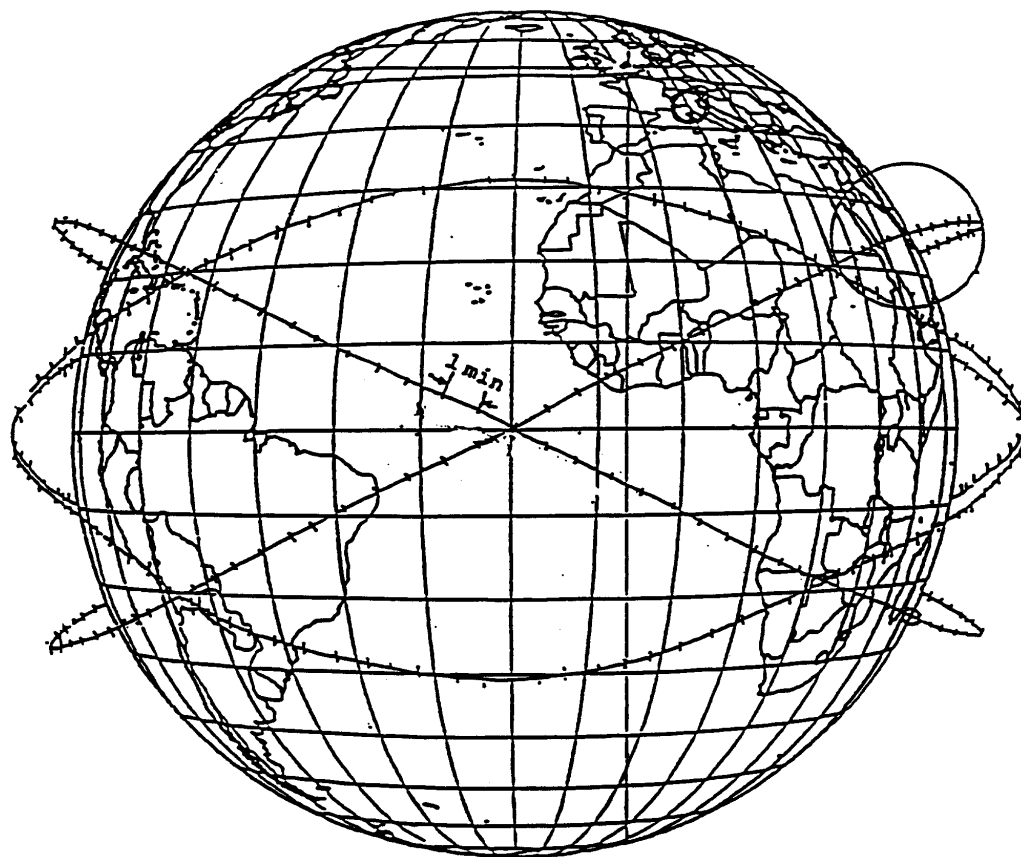


**Second Ka-Band Utilization Conference
September 24 - 26, 1996
Florence, Italy**

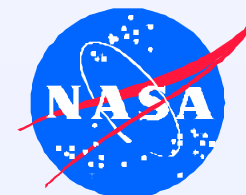
**Badri Younes (NASA CLASS Project Manager)
John E. Miller (STel)**



Source of Interference

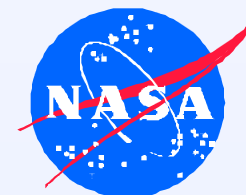


$I < -148 \text{ dB(W/MHz)}$
 $G_r = 58 \text{ dBi}$
 $\text{EIRP} < 7.5 \text{ dB(W/MHz)}$



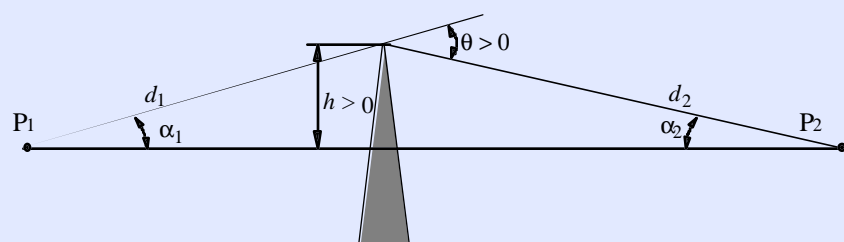
Background

- WARC-92 allocated the 25.25-27.5 GHz band to the Inter-Satellite, Fixed and Mobile Services on a primary basis.
- In accordance with RR 2504A (WARC-92), the objective is to prepare an ITU-R Recommendation on the limits on the e.i.r.p. density of fixed service stations necessary to protect data relay satellite operations in the 25.25-27.5 GHz band. Interference must not exceed -148 dB(W/MHz) for more than 0.1% of the time (Recommendation ITU-R SA.1155).
- Summary of ITU-R Joint Ad Hoc Working Party 7B-9D studies in support of a preliminary draft new recommendation applicable to point-to-point fixed service systems.
 - Temporal characteristics of interference to DRSs
 - Protect orbital locations of DRSs
 - Use automatic transmit-power control
 - Account for atmospheric absorption on a case-by-case basis
 - Account for Fresnel zone blockage on a case-by-case basis



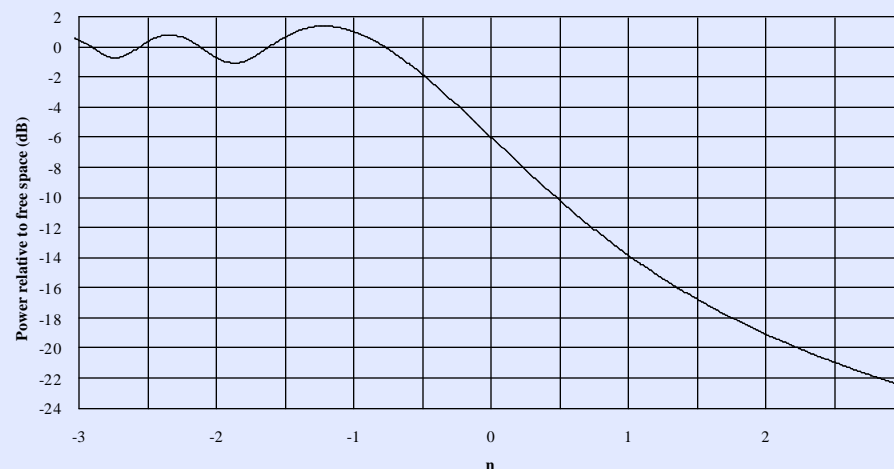
Fresnel Zone Blockage

**Diffraction loss computed using the methods of
Recommendation ITU-R PN.526-3.**

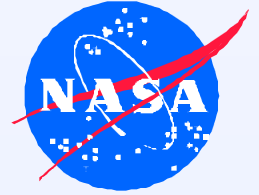


$$v = \theta \sqrt{\frac{2d_1}{\lambda}}$$

$$v = 833 \cdot \theta$$



**P₁ located 4 km from the obstacle
f = 26 GHz**



Fresnel Zone Blockage (cont.)

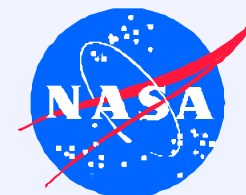
Evaluation of the sensitivity of diffraction loss to diurnal variations in the data relay satellite orbit and nominal off-set angle.

- Fixed service station is located 4 km from the knife-edge diffracting obstacle.
- The data relay satellite orbit is inclined by 0.1 degrees.
- The latitude, ϕ_s , and longitude, $\Delta\lambda_s$, of the subsatellite point for a slightly inclined orbit, i , as a function of the Earth's rotational rate, ω_e , and time, t , is

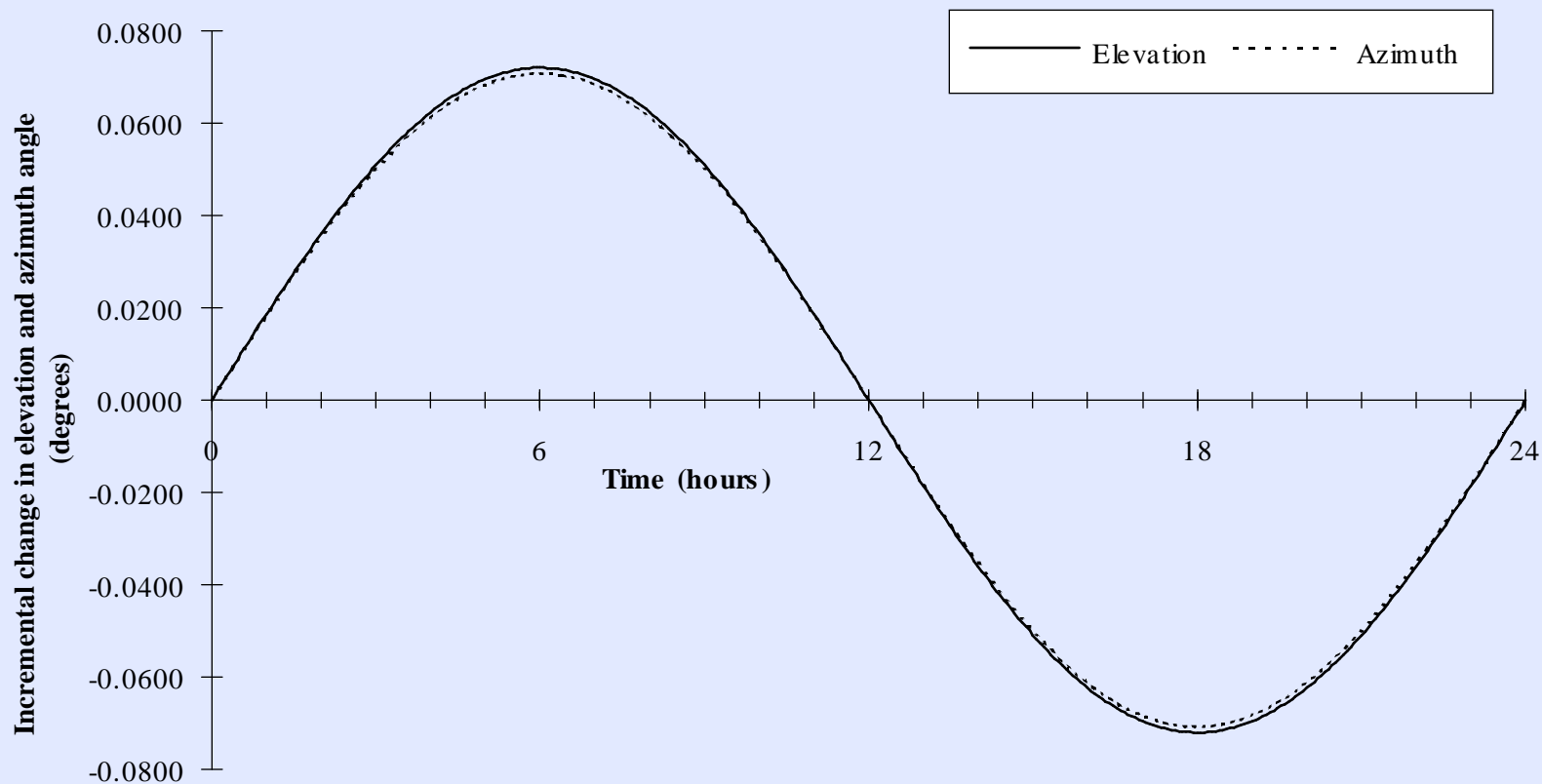
$$\phi_s = i \sin(\omega_e t)$$

$$\Delta\lambda_s = 0.25 i^2 \sin(2\omega_e t)$$

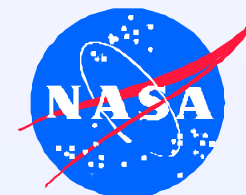
- Nominal ray from the fixed service station to the data relay satellite orbital location intersects:
 - The top of the diffracting obstacle
 - 0.1 degrees below the diffracting obstacle
 - 0.1 degrees above the diffracting obstacle



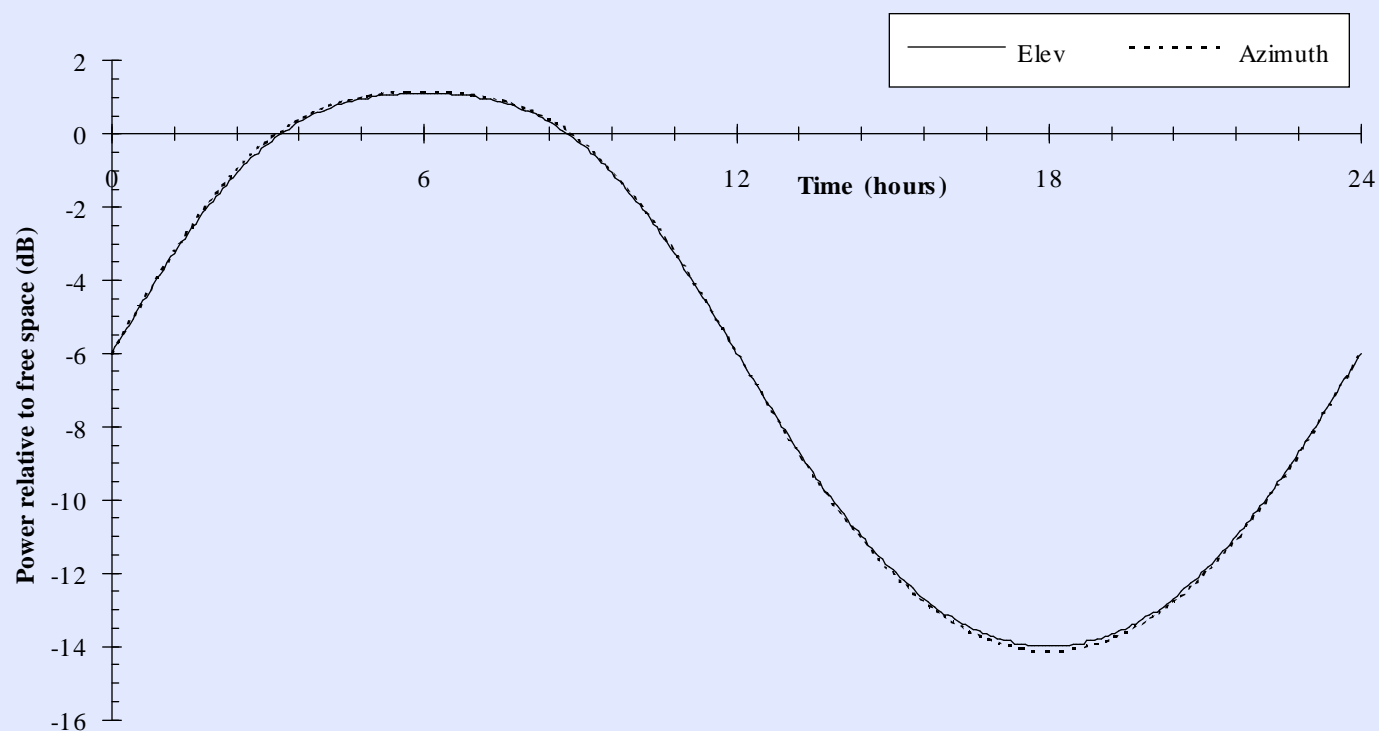
Fresnel Zone Blockage (cont.)



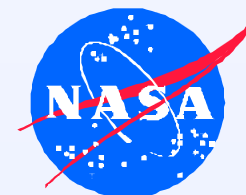
Diurnal variation in the relative azimuth and elevation angle for a station located at 45 degrees N. latitude.



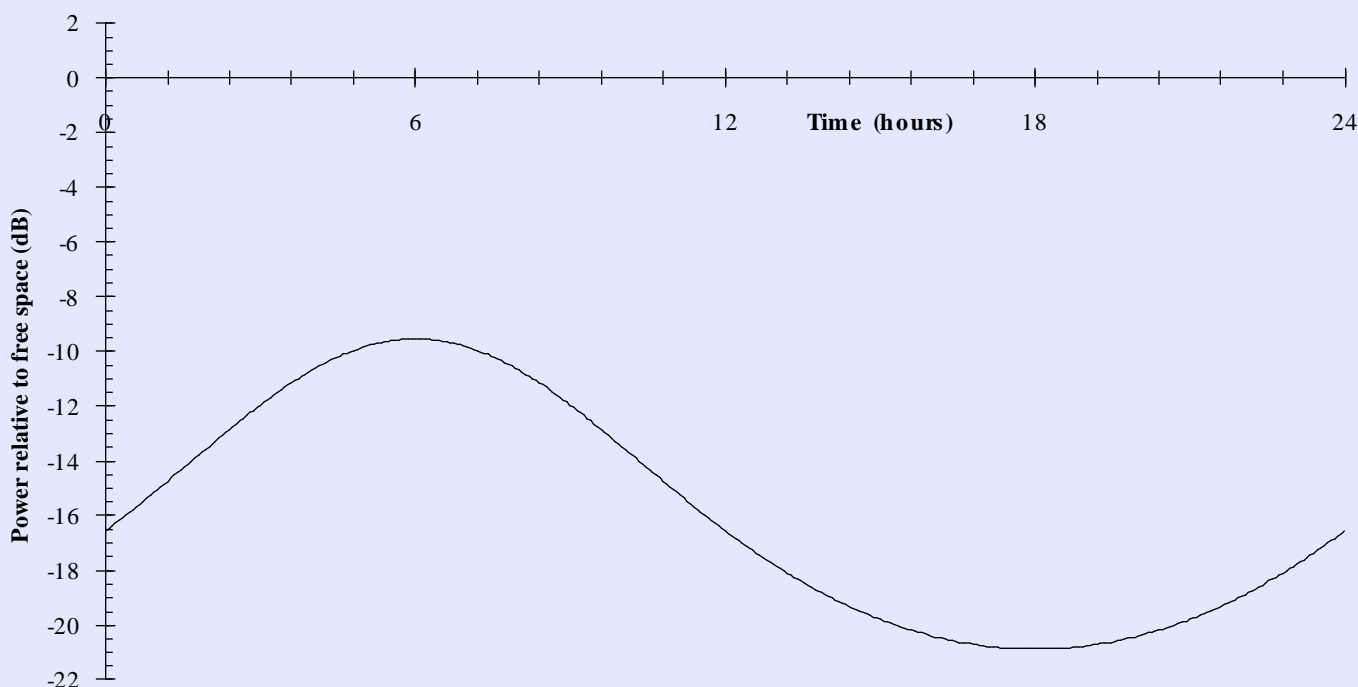
Fresnel Zone Blockage (cont.)



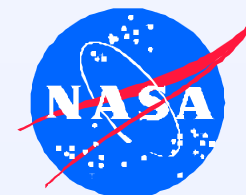
Diurnal variation in the diffraction loss for a station located at 45 degrees N. latitude: Nominal data relay satellite position seen at the top of the obstacle.



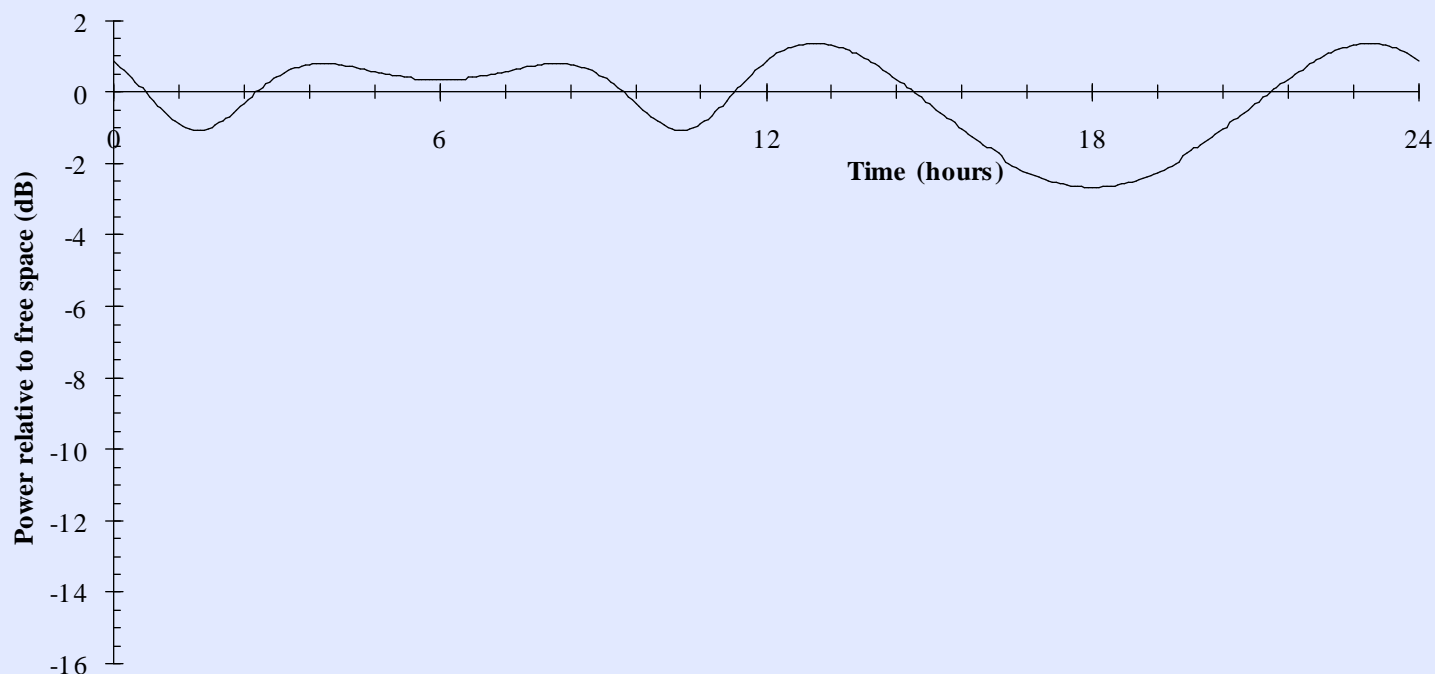
Fresnel Zone Blockage (cont.)



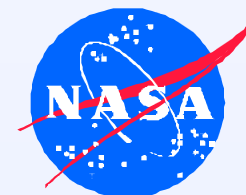
Diurnal variation in the diffraction loss for a station located at 45 degrees N. latitude: Nominal data relay satellite position seen 0.1 degrees below the top of the obstacle.



Fresnel Zone Blockage (cont.)

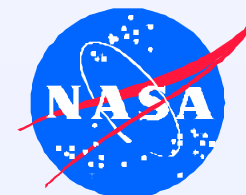


Diurnal variation in the diffraction loss for a station located at 45 degrees N. latitude: Nominal data relay satellite position seen 0.1 degrees above the top of the obstacle.

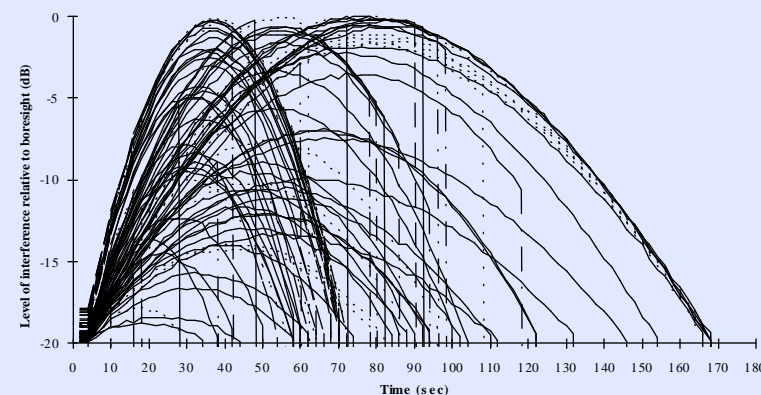
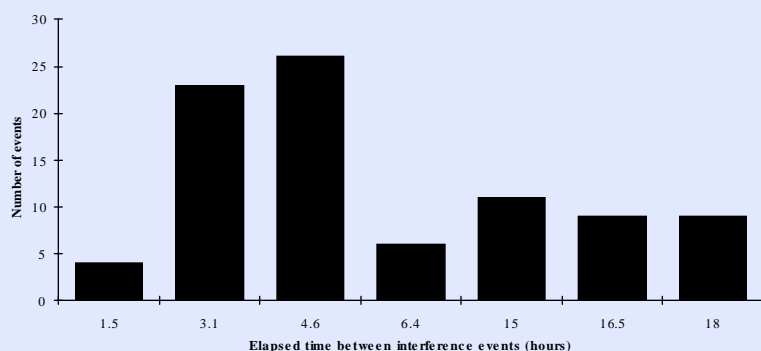


Summary and Conclusions

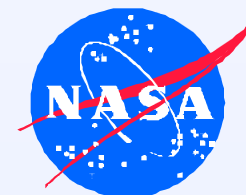
- **Diffraction loss due to Fresnel zone blockage is very sensitive to the geometry of the propagation path and the latitude of the fixed service station.**
- **Joint Ad Hoc WP 7B-9D is nearing completion of a preliminary draft new recommendation to prevent unacceptable interference from the emissions of point-to-point fixed service stations.**
- **Study is required to determine the characteristics of point-to-multipoint fixed service stations that will not cause unacceptable interference to data relay satellites in the 25.25-27.5 GHz band.**



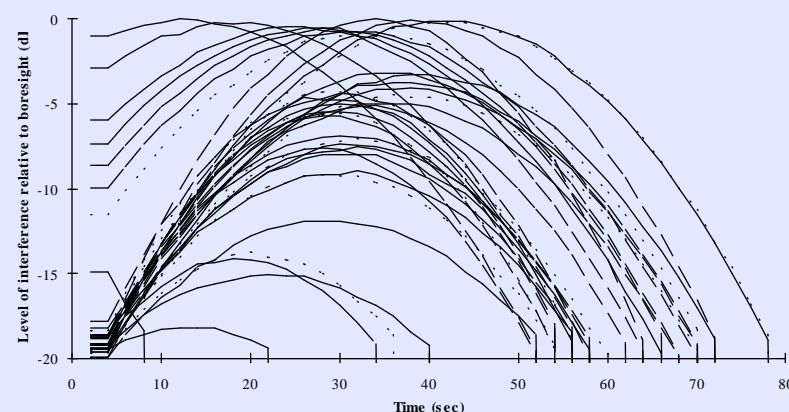
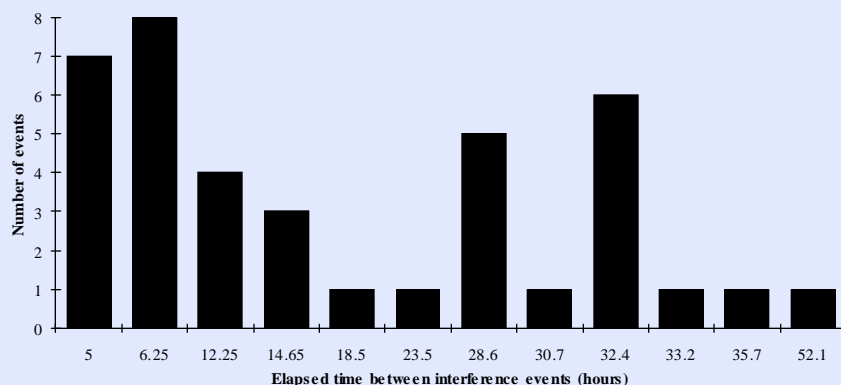
Temporal Characteristics of Interference



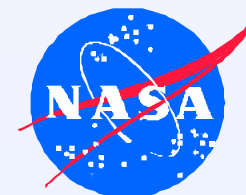
**For a satellite in an International Space Station type orbit:
 $h = 350$ km; and inclination = 51.7 degrees; FS station
located at 45 degrees N. latitude.**



Temporal Characteristics of Interference (cont.)



**For a satellite in an Earth observation type orbit:
 $h = 797$ km; and inclination = 98.6 degrees; FS station
located at 45 degrees N. latitude.**



Atmospheric Absorption

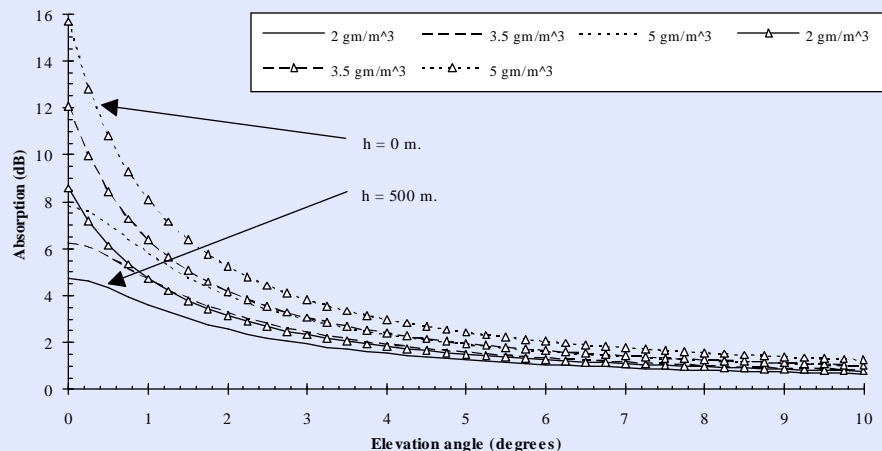
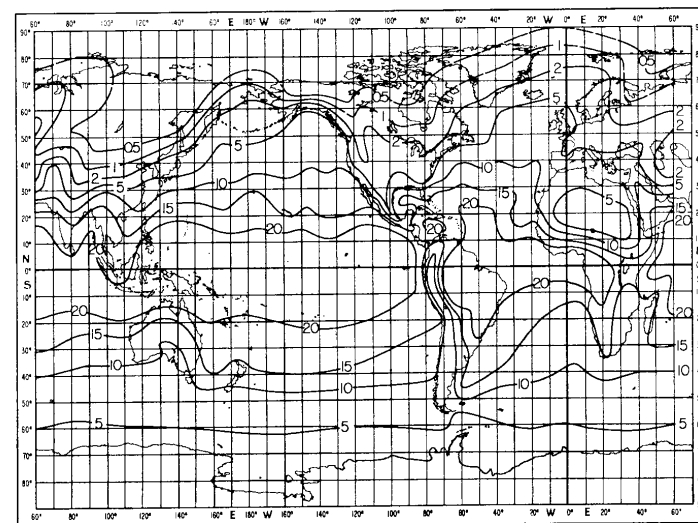


FIGURE 1
Water vapour density (g/m^3), February



Attenuation computed using Recommendation ITU-R PN.676-1
Surface water vapor density from Recommendation ITU-R PN.676-1